



Complexity or simplicity? Designing product pictures for advertising in online marketplaces



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ABSTRACT

In online marketplaces, many sellers highlight product and service information directly within product pictures for advertising purposes. Such a strategy increases the visual complexity of the picture and provides more information to support buyers' judgment. However, when other sellers adopt the same method, a given picture will not be conspicuous enough to be noticed. To address this issue, the concept of complexity contrast is introduced. No prior attention has been paid in literature to the interplay between visual complexity and complexity contrast. This research proposes a theoretical model to explain the influences of visual complexity and complexity contrast on buyers' pleasantness in shopping, while perceptual and conceptual fluency act as mediators. Results from a lab experiment suggest an entangled effect of complexity contrast and visual complexity, indicating that buyers are influenced more by the conspicuousness of a product picture, rather than the information conveyed by a product picture when it is visually overwhelming.

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1. Introduction

In online marketplaces, buyers receive a list of sellers when they search for a certain product. Within the list, a few alternatives will be selected for further evaluation. Therefore, how to increase the probability of being chosen is an important consideration for every seller. Similar to search engine advertising (Gauzente, 2010), there exist many approaches for advertising in online marketplaces, such as writing accurate keywords in the product title and purchasing sponsored positions in the result list. Moreover, since the result list shows product pictures, many sellers begin to edit their product pictures by adding extra information, making the product pictures virtually complex. This advertising method makes sense for two reasons. First, the textual information in the result list only contains basic product characteristics (e.g., title, name of seller, location, and price), while many product or service specifications that are likely to be strong influences on buyers' decisions (e.g., promotions, product features, service guarantees, and rewards) cannot be advertised due to space limitation. Thus, the product pictures become a major window for displaying these highlights. Moreover, pictures can convey information more

efficiently than textual messages (Geise and Baden, 2015). Second, by directly viewing product highlights from product pictures, buyers can save much time and effort since they can learn more about the products or services without clicking into the details pages.

The situation becomes complicated when other sellers also adopt the same advertising strategy. Too many complex pictures could cause a serious visual overload problem, which makes it difficult for buyers to locate and process product information (Mazzoni et al., 2014; Taobao, 2012). To deal with this problem, some sellers use simple pictures strategy and display only product images to attract buyer's attention. Nevertheless, the advertising effectiveness remains unclear.

The objective of this study is to evaluate the effectiveness of the advertising strategy that tries to create visual salience in terms of complexity contrast of a given picture against its surrounding pictures (referred to as visual complexity contrast hereinafter). As advertising effectiveness is closely related to buyers' processing of product information, we attribute this issue to the concept of "processing fluency" (Reber et al., 2004). This concept is related to (1) the visual search of the product picture (i.e., whether buyers notice the picture among a list of pictures), and (2) the visual complexity of the product picture (i.e., whether buyers can easily process the information contained in the product picture).

This study is expected to address several gaps in current research. First, studies on visual complexity in an online context

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focus mainly on entire web pages and banner ads (Kao and Wang, 2013; Liqiong and Poole, 2010), while other web objects (e.g., search list, product picture) have earned little attention. Moreover, regarding the experiments in these studies, researchers usually do not consider the influences of environmental setting (e.g., a set of pictures). Rather, they are only concerned about participants' perceptions of a visual object (e.g., a picture) and followed responses (e.g., recall, satisfaction) (Martin et al., 2005; Michailidou et al., 2008). Second, while the effects of different forms of visual salience (e.g., color contrast and luminance contrast) have been extensively studied, little is known about the effects of visual complexity contrast. Third, previous online marketing research emphasizes the importance of processing fluency on consumers' attitudes and behavioral intentions, while limited attention has been paid to how informational features of web objects affect consumers' processing. This study also has the potential to provide practical insights regarding dynamic adjustment of advertising strategies according to environmental changes.

The rest of this paper is organized as follows: We provide a review on visual complexity, visual complexity contrast, and processing fluency in Section 2. The conceptual framework and related hypotheses are presented in Section 3, while Section 4 describes experiment preparations. We explain the formal experiments and analysis in Section 5, discuss our findings, implications, and limitations in Section 6, and finally draw our conclusions in Section 7.

2. Literature review

2.1. Visual complexity

Visual complexity of an object (e.g., a web page or an image) refers to the number of elements presented in the object and the level of information detail conveyed by these elements (Liqiong and Poole, 2010). Currently, researchers have not reached consensus on measuring visual complexity. Some studies treat visual complexity as a first-order construct (Michailidou et al., 2008; Orth and Wirtz, 2014; Tuch et al., 2009), while others divide visual complexity into several sub-dimensions (e.g., feature and design complexity) (Pieters et al., 2010). The categorization of sub-dimensions is also different across different studies. Following these

previous studies (Tuch et al., 2012), we are primarily interested in visual complexity as subjectively perceived by users.

There has been a long debate about whether to use complex or simple design (Putrevu et al., 2004). The logic of using simple design is that consumers have limited processing ability and they seek to minimize the cognitive effort used on processing visual objects. Meanwhile, the reason for using complex design is that rich information cues facilitate the evaluation of visual objects. The literature shows results to be mixed, as some studies suggest that simple ads are better (Anderson and Jolson, 1980), while others advocate complex ads (Lowrey, 1998).

Compared with offline channels (e.g., print media and TV), consumers are more likely to be exposed to excessive information in an online context. Besides, the cost of context switching online (e.g., changing website, closing web pages) is relatively low. Therefore, it is important for designers to consider the visual complexity of web objects as it influences multiple aspects of human cognition and emotion, such as satisfaction, memory, and task performance (Geissler et al., 2006; Tuch et al., 2009).

A summary of recent work in the online context is shown in Table 1. The effects of visual complexity have been explored from various aspects, including different types of websites (e.g., general or commercial) and different web elements (e.g., the whole web page or a single web page element). However, there exist two points that require more attention. First, the majority of work is devoted to evaluating the complexity of web pages and banner ads, while study on other web objects is limited. Specifically, no studies have examined on how to determine the level of visual complexity of a web object according to its context on the page (e.g., a seller's product picture in a list of competitors' product pictures). Studies on human attention suggest that the salience of a visual object is not only determined by its own design, but also by its contrast to other objects in the same setting (Gauch et al., 2007; Matt et al., 2014). Second, most studies tend to evaluate human responses to an object (e.g., a banner ad) with a given level of visual complexity. Since sellers in online marketplaces use product pictures to highlight product attributes, it is reasonable to take the buyer's attitude towards the product into account, rather than only considering her affective response (e.g., perceived beauty) to the product picture.

Table 1
Summary of recent studies on visual complexity in online context.

Study	Context	Complexity variable	Level of analysis	Descendant variables
Mosteller et al. (2014)	E-commerce website	Perceptual fluency (Information Intensity)	Page	Satisfaction, Cognitive Effort, Positive affect
Mai et al. (2014)	General website	Website Complexity	Page	Perceived speed, Ease of navigation, Perceived control, Focused attention, Enjoyment, Attitude
Kao and Wang (2013)	E-commerce	Complexity	Banner ads	Preference
Tuch et al. (2012)	Company website	Visual complexity	Page	Perceived Beauty
Cui et al. (2012)	News & E-commerce	Complexity (Component, Co-ordinative, Dynamic)	Page	Satisfaction, Cognitive Style
Liqiong and Poole (2010)	General	Visual Complexity	Page	Arousal, Pleasantness, Approach-Avoidance Behavior
Tuch et al. (2009)	General	Visual Complexity	Page	Arousal, Valence, facial expression, nervous system
Jala Krishen et al. (2008)	General	Actual complexity Perceived Complexity	Page	Satisfaction, Website Liking
Michailidou et al. (2008)	Various Type	Visual complexity	Page	Aesthetic appearance (5 dimensions)
Nadkarni and Gupta (2007)	Various Types	Complexity (Component, Co-ordinative, Dynamic)	Page	Satisfaction, Familiarity, Task Type
Guo and Scott (2006)	E-commerce	Complexity(overall, presentation, navigation)	Page	Flow experience (7 dimensions)
Geissler et al. (2006)	E-commerce	Complexity	Page	Attention, Attitude, Purchase Intention
Yun Yoo and Kim (2005)	General	Animation	Banner ads	Attitude, Memory, Recall
Martin, et al., (2005)	E-commerce	Visual Complexity	Page	Need for cognition, Sensation seeking, Attitude, Intention
Huhmann (2003)	General	Visual Complexity	Banner ads	Recall

2.2. Visual complexity contrast

The biased competition theory of attention (Desimone and Duncan, 1995) suggests that the processing capacity of the human visual system is limited and that each element presented in the visual field competes for neural representation and cognitive processing. When people pay attention to one visual object, less processing capacity is available for other visual objects. People's selective attention can be triggered by a bottom-up stimulus-driven mechanism, which occurs due to the dissimilarity between an object and distractors.

In online shopping, buyers' decisions are affected by their visual attention, especially when they are confronted with an overload of available information (Clement et al., 2015). The majority of the existing studies focus on types of dissimilarity, such as color, shape, luminance and animating. For example, Petiet (2012) finds that a product with a high color contrast to its background earns more attention than other products. Al-Natour et al. (2013) propose that animating an ad increases its figure-background contrast and introduces visual priming. Turatto and Galfano (2000) find that color, shape, and luminance contrasts attract human attention, and, further, more salient products (e.g., those with high color contrast) have been found more likely to be purchased than less salient products (Chandon and Wansink, 2002).

However, studies investigating the effects of visual complexity contrast in online marketing are rare. In the field of icon design, one study shows that in addition to color contrast and shape contrast, icons with complexity tend to influence people's visual search (Huang, 2008). For example, a "PRINT" icon that displays the borderline of a professional printer can be noticed more easily than a "POST" icon that contains a folded paper. Therefore, it is reasonable to expect that visual complexity contrast may increase the distinctiveness of a visual object and can be used as an advertising strategy to attract more attention and influence buyers' decisions in online marketplaces.

2.3. Processing fluency

Processing fluency refers to the metacognitive experience regarding the ease or speed with which information is extracted from an object (Scheel et al., 2014). Two forms of processing fluency have been recognized: perceptual fluency and conceptual fluency. These two forms indicate the ease of identifying and processing the physical features (low level) and semantic meaning (high level) of a stimulus, respectively (Reber et al., 2004). Processing fluency towards a stimulus can be manipulated by a number of variables through both perceptual and conceptual processes. For example, figure-ground contrast, clarity, length, and repetition of exposure can influence a low level of processing fluency (perceptual fluency); and the amount of information, the consistency between stimulus and its context can influence a high level of processing fluency (conceptual fluency) (Kao and Wang, 2013; Knijnenburg et al., 2012; Reber et al., 2004).

Processing fluency acts as an important variable that influences subsequent human judgment and actual behavior (Knijnenburg et al., 2012; Mosteller et al., 2014). The fluent processing of a stimulus indicates error-free processing and successful identification of a stimulus (Orth and Wirtz, 2014), and it instantaneously triggers positive affects because fluency itself signals several inherently preferred states (e.g., safety) (Herrmann et al., 2013). Prior marketing studies consider processing fluency to be closely related to the advertising outcome of ads, such as attitudes towards the ads and brand judgments (Wang et al., 2013). Furthermore, studies on human decision-making show that processing fluency contributes to people's confidence in their decisions (Lee and Aaker, 2004). As positive affects usually trigger intention or

real behavior (Agrebi and Jallais, 2015), in this paper we choose to measure buyers' shopping pleasantness as an outcome of their processing fluency.

While existing studies emphasize the importance of processing fluency on consumers' attitudes and behavioral intentions, limited attention has been paid to how informational features of web objects affect consumers' processing. Several exceptions include work on perceived complexity (Mosteller et al., 2014; Nadkarni and Gupta, 2007) and information quality (Im et al., 2010). Furthermore, current studies only explain the separate effects of experiment manipulations (e.g., complexity or contrast), while the entangled effects of multiple manipulations (e.g., complexity plus contrast) on people's processing fluency have been largely neglected.

3. Theoretical framework and research hypotheses

The research model proposed in this study is rooted in the stimulus-organism-response (S-O-R) framework. The S-O-R model suggests that environmental features (stimuli) change people's internal states (organism), which further affect behavioral intent and responses (Mehrabian and Russell, 1974). Previous studies have evaluated the effects of online store design features (e.g., aesthetics and design) on buyers' emotional and behavioral responses (Eroglu et al., 2003; Mosteller et al., 2014; Mummalaneni, 2005). These findings show that the S-O-R framework is a viable model in the e-commerce context.

In this study, visual complexity and visual complexity contrast serve as the stimuli presented to buyers. The former has been used as a stimulus in previous studies (Liqiong and Poole, 2010; Mosteller et al., 2014), and the latter is a new stimulus introduced in this paper. Prior work has demonstrated the effects of environmental features on online buyers' internal states (Eroglu et al., 2003; Gao and Bai, 2014), therefore we expect that visual complexity contrast will exhibit a significant effect on buyers' internal states. Processing fluency is seen as an important "organism" factor sharpened by buyers' perception of the presented information (Mosteller et al., 2014), and shopping pleasantness is considered a "response" factor. The whole conceptual model is presented in Fig. 1, which consists of two sub-models based on two advertising strategies: (1) visual complexity of a product picture; and (2) visual complexity contrast of a product picture against surrounding pictures (e.g., posting a simple picture among complex pictures, or posting a complex picture among simple pictures). The related hypotheses are proposed as follows.

3.1. "Response": Effect of processing fluency on pleasantness

The Hedonic Fluency Model suggests that high processing fluency leads to a favorable affective response (Xiao and Benbasat, 2007). Two possible reasons suggested by Reber et al. (2004) fit our study context: (1) the features of an object (e.g., goodness of form) that facilitate fluent processing contribute to the beauty of the object (e.g., clear font, favorable color) and lead to aesthetic pleasure. (2) High fluency (e.g., locating and reading information quickly) is subjectively treated as a positive experience. According to the difficulty law of motivation, experiencing difficulties during information processing (low processing fluency) automatically signals increased need of cognitive effort, especially when people cannot avoid executing the task (Dreisbach and Fischer, 2011; Murakami et al., 2008). A high level of cognitive effort usually leads to low levels of satisfaction (Mosteller et al., 2014). On the contrary, fluent processing usually leads to a sense of confidence (Song and Schwarz, 2008). In the online shopping context, if buyers read the product information fluently, such ease of

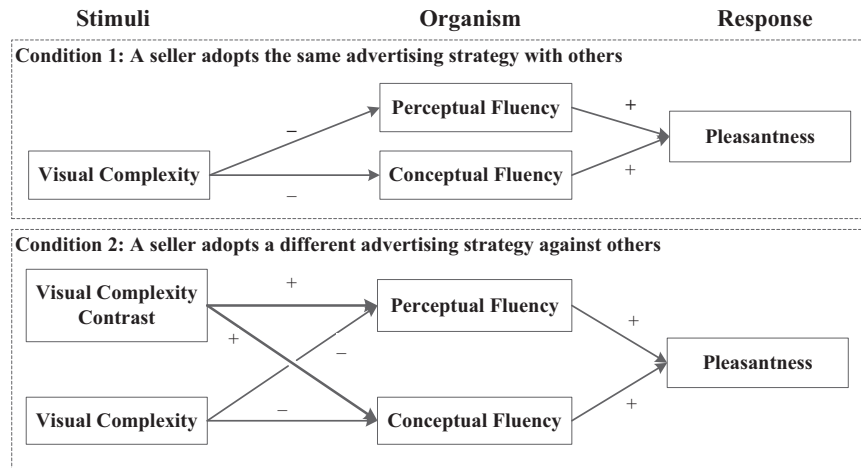


Fig. 1. A conceptual model of visual complexity and visual complexity contrast.

processing information might result in a favorable evaluation of the product being described in the picture/text (Mosteller et al., 2014).

Therefore, considering processing effort is a general term used to capture the commonalities of perceptual and conceptual fluency, it is hypothesized that, for a given product picture,

H1. Buyers' perceptual fluency increases their shopping pleasantness.

H2. Buyers' conceptual fluency increases their shopping pleasantness.

3.2. "Organism": Effect of visual complexity on processing fluency

As mentioned earlier, processing fluency refers to the ease of processing information extracted from a stimulus. Therefore, the amount of information extracted from the object determines processing fluency towards the objects. A high amount of information (high complexity) leads to low processing fluency, because people need more effort to extract physical features. Meanwhile, as the amount of information increases, the number of possible semantic explanations also increases (Gay, 1986). Therefore, people need more cognitive effort to understand the semantic meaning of physical features in the given context (e.g., a picture of a product) based on their knowledge. On the contrary, a simple stimulus only contains a small amount of information and it is much easier to process (Reber et al., 2004; Wang et al., 2010). Previous studies suggest that visual complexity has an inverted U shape impact on many variables (e.g., enjoyment) (Mai et al., 2014; Tuch et al., 2009). The relationship between visual complexity and fluency, however, is often found to be linear (Hoffmann et al., 2011; Mai et al., 2014). Processing fluency and complexity are so conceptually related that many studies manipulate subjects' processing fluency by providing stimulus materials in different forms of complexity (e.g., amount of information, information density, or semantic complexity) (McNee et al., 2006; Mosteller et al., 2014; Wang et al., 2010).

Therefore, it is hypothesized that, for a given product picture,

H3. the visual complexity is negatively associated with buyers' perceptual fluency.

H4. the visual complexity is negatively associated with buyers'

conceptual fluency.

3.3. "Organism": Effects of visual complexity contrast

In previous studies, various types of contrast (e.g., luminance or color) have been used to manipulate perceptual fluency (Unkelbach, 2006; Vig et al., 2009; Ziegler et al., 2005). In this view, regarding the visual complexity contrast of product images, a complex (or simple) image positioned in a list of simple (or complex) product images will easily gain a consumer's attention. Such priority will impact the processing of the product picture in two ways. First, the image will be noticed earlier than other images (perceptual level), and second, more cognitive resources will be allocated to the image and fewer cognitive resources will be allocated to irrelevant visual distractors (Lavie, 1995). As a result, the processing of the image will be more efficient, on both the perceptual and conceptual levels. Since complexity contrast mostly induces visual priming and facilitates information processing at the perceptual level (Winkielman et al., 2000), it is reasonable to expect that complexity contrast is more important for perceptual processing than visual complexity. Moreover, by introducing complexity contrast, fewer cognitive resources will be spent on distractors. Therefore, a high level of visual complexity will not cause a low level of processing fluency as it does in cases without complexity contrast. However, for conceptual fluency, visual complexity is still expected to have a stronger influence than complexity contrast.

Thus, it is hypothesized that, when a seller posts a simple picture among complex pictures (or posts a complex picture among simple pictures),

H5. The complexity contrast of the product picture is positively associated with buyer's perceptual fluency.

H6. The complexity contrast of the product picture is positively associated with buyers' conceptual fluency.

H7. Complexity contrast exerts a stronger impact on perceptual fluency than visual complexity.

H8. Complexity contrast exerts a weaker impact on conceptual fluency than visual complexity.

H9. Visual complexity exerts a weaker impact on both perceptual fluency and conceptual fluency than in the condition where a

seller posts a picture with the same level of complexity as others.

4. Experiment preparations

Three steps are taken to prepare experimental data: selection of an online marketplace, a product category, and product images.

We selected Taobao as the target marketplace based on two reasons. First, Taobao is the largest online marketplace in China with 90% market share. It had a larger transaction volume than Amazon and eBay combined in 2013 (Popper, 2014), is well known among Chinese communities, having half a billion registered users, and covers a wide range of product categories. Taobao is usually considered a typical e-commerce case in previous studies (Clemes et al., 2014; Wu et al., 2015). Second, unlike other online platforms (e.g., Amazon) which have professional standards for producing high-quality product images, online marketplaces like Taobao and eBay usually do not have strict regulations on product images; most of the product pictures are taken and edited by the sellers themselves. As a result, the phenomenon of using complex product pictures is very pervasive, especially in Taobao.

A product category is considered appropriate when it is neither well-known among subjects nor liked or disliked by subjects. Familiarity with a certain product category may influence participants' perceived complexity of the stimuli, and it is likely to generate top-down selective attention (Engel et al., 2001). Meanwhile, we prefer a product category toward which participants showed a neutral attitude so that we can assume the major influence on their reported organism is the manipulation of stimuli in the experiment (Liqiong and Poole, 2010). To improve efficiency, only twenty product categories are selected. Fifty unknown students in a Chinese university are randomly invited to respond to two questions on each product category. A five-point scale is used to measure responses to two questions (not familiar/familiar, not like/like). Finally, the target product category of “fishing rods” is selected because this category received the lowest score on familiarity (mean: 1.04, S.D.: 0.20) and the most neutral attitude (mean: 3.98, S.D.:0.25).

When we choose product images with appropriate complexity, we only select product pictures with a white background as alternatives in order to reduce the possible interference effect of figure–background contrast. Three graduate students who have online shopping experience are invited to judge the visual complexity of 200 product images based on a question measured by a five-point scale from very simple to very complex. The three scores are then averaged to indicate the level of visual complexity of each product picture. As the number of products listed in a Taobao result page is around 40, the formal experiment follows this rule and the top 40 simple and the top 40 complex pictures are selected.

We modify product pictures and product information based on the following rules. First, since participants use pre-determined criteria given in the formal experiment to select a product, we slightly modify complex pictures by adding any missing criteria-related information. For simple pictures, on the other hand, detail pages are created to show their criteria-related information. As

such, we ensure that the information provided in each complex picture or product detail page is enough to make a purchase decision. Second, we select one simple picture and one complex picture as the pictures of target products (the products which meet all criteria). We modify the information of other products to make sure they do not meet the criteria.

5. Lab experiment

We chose to conduct a lab experiment so as to retain control over a number of intervening variables such as previous experience, familiarity, and purchase budget. In accordance with many marketing studies, only one product category (fishing rod) is used in the experiment (Mosteller et al., 2014). Previous studies usually use the recall rate to measure advertising effectiveness (Byoung-Chun et al., 2011); however, this method is inappropriate for this study because we are interested in product choice rather than memory of product pictures.

5.1. Scenario

Each participant in the lab experiment was provided a web page containing the following text:

Imagine that you are planning to buy a gift for an important person (e.g., father, supervisor) to celebrate his/her birthday. You have consulted his/her spouse and you are told that a fishing rod is the best option. Since you are not familiar with the fishing rod, you have to ask a reliable expert for suggestions about selection criteria. With these criteria, you search in Taobao and receive a list of products. The criteria and product list are shown in next page. You have to select an appropriate product from the list of results. Please note that the price of each product in the list is acceptable. We are interested in how product images influence your product selection experience.

After reading the first web page, each participant clicked an “enter” button to be directed to the second page, which contained five pre-determined selection criteria (promotion, material, length, function, and guarantee) and 40 products. The sequence of 40 products (10 rows and 4 columns, with a picture size of 250px × 250px) in the list was randomly assigned in order to reduce potential interference of the primacy effect. The selection of 40 images assigned to each participant randomly fell into one of the four conditions (Complexity: Low/High; Contrast: without high contrast/with high contrast) listed in Table 2. As such, conditions 1 and 2 match the case when a seller adopts the same advertising strategy with others (without complexity contrast). And conditions 3 and 4 match the case when a seller adopts a different advertising strategy (with complexity contrast). Parts of the interface of condition 3 can be found in Appendix A.

Each original product title was replaced with “High Quality Fishing Rod” because many sellers also use the product title to advertise. Meanwhile, information cues such as seller reputation, sales amount and product location were hidden because we need to ensure that participants' choices of alternative products are

Table 2
Manipulation of lab experiment.

Group	Condition	Visual complexity	Contrast	Details
Without contrast	1	Low	No	Target product image (simple); 39 distractor images (simple)
	2	High	No	Target product image (complex); 39 distractor images (complex)
With contrast	3	Low	Yes	Target product image (simple); 39 distractor images (complex)
	4	High	Yes	Target product image (complex); 39 distractor images (simple)

influenced only by the information provided in the product pictures and product detail pages. When a participant moved his mouse over a complex picture, a button labeled “Buy this one” would be shown on the picture. And when the mouse was moved over a simple picture, a button labeled “Go to detail page” would be shown to direct the participant to the related product detail page, which also contained a button labeled “Buy this one”. The participants took part in a survey as soon as they chose a product.

5.2. Participants

The sample for this lab experiment was composed of undergraduate students from a large Chinese university. An open invitation was made by posters and on an in-campus online forum. To encourage participation, the invitation announced that each participant who provided valid feedback would receive USD\$ 0.8 (CNY ¥5) as a reward for their time spent in the experiment. Each participant was required to have purchase experience in Taobao and should not be familiar with fishing equipment. Participants were randomly assigned to one of the four conditions (see Table 2), each of which was set to contain 100 participants. New participants were not accepted once each condition had enough participants. Since the experiment adopted a first-come-first-serve strategy, there was no time schedule for any participant.

The participants were largely undergraduates since the campus where the invitation was sent was mainly used for undergraduate study. Four hundred students participated in the experiment and the valid rate of responses was 100% because a computer program was developed to control survey completion. The demographic information of the 400 participants is summarized in Table 3. The number of participants meets the requirement of Partial Least Squares (PLS) analysis. This sample is suitable since previous studies report that young adults and university students are a typical group of online consumers, and a similar sampling approach has also been employed in previous studies (Kim et al., 2008; Komiak and Benbasat, 2006; Liqiong and Poole, 2010; Tarnanidis et al., 2015). Moreover, a recent official survey shows that 56.4% of Chinese C2C consumers are aged between 20 and 29, 35.9% of consumers have (or are pursuing for) bachelor degrees, and the percentages of male and female consumers are by and large equal (CNNIC, 2014).

5.3. Measures

A seven-point scale was used to measure items. *Visual complexity* of the target product image is measured by four items (labeled from “COM1” to “COM4”: complex, crowded, variety, complicated) adopted from two studies (Geissler et al., 2006; Jala Krishen et al., 2008), with the scale labeled from “not at all” to “a lot”. For the measurement *complexity contrast*, previous studies usually use physical attributions of images (e.g., size of a picture); however, this method is inappropriate because it does not reflect

human perception. Three self-developed items were used to measure complexity contrast including “comparing to other products, the picture of the product you selected is: not distinguishable/distinguishable (CON1); conspicuous/inconspicuous (CON2, reverse coded)” and “the differences of complexity between your product picture and other pictures is: very low/very high (CON3)”. *Pleasantness* was measured by three items adopted from (Liqiong and Poole, 2010): “The shopping experience with your selection is: enjoyable (PLEA1), pleasurable (PLEA2), satisfied (PLEA3)”, with the scale labeled from “not at all” to “a lot”. We chose to measure participants’ whole shopping experience because their purchase decisions are made based on information provided in product pictures or detail pages. Finally, we used self-developed items to measure processing fluency as there is no consensus in the present literature. However, these self-developed items were developed based on previous studies (Tang et al., 2014). *Perceptual fluency* was modeled as a formative latent construct with four items. These four items reflect two forms of perceptual fluency: locating product picture and perceptually processing product information). A formative representation of perceptual fluency is preferred because an increase in one aspect of fluency (e.g., locating a picture) may not cause an increase in the other aspect of fluency (e.g., identifying information cues in a picture). As a result, changes in one indicator influence the formative construct, yet a change in the construct may not necessarily impact all its observed items (Andreev et al., 2009). The four items are: “The picture of the product you selected instantly attracts your attention among all the products (PERF1)”, “The picture of the product you selected stands out in the whole group of pictures (PERF2)”, “the product information presented in the product picture or in the product detail page is easy to view (PERF3),” and “it is easy to identify information pieces presented in the product picture or in the product detail page (PERF4)”. *Conceptual fluency* is measured by two items: “it is easy to understand the information in the product picture or in the product detail page (CONF1)” and “you are able to effortlessly comprehend the information in the picture or in the product detail page (CONF2)”. The scale of these six items is labeled from “completely disagree” to “completely agree”.

5.4. Partial least squares analysis

The test of the measurement and structural models apply structural equation modeling (SEM)-based PLS analysis using WarpPLS 4.0 with bootstrapping (Kock, 2011). PLS analysis is chosen because it does not require the distribution of the sample to follow multivariate normality (Kallweit et al., 2014). In line with other PLS software, the classic PLS algorithm is adopted. The analysis in this study follows Yoo and Alavi’s (2001) work.

5.4.1. Measurement model

In PLS analysis, the measurement model is tested by examining: (1) individual item reliability, which is reflected by the

Table 3
Demographic information of participants.

Items	Mean	S.D.	Min	Max	Comment
1.Age	22.08/ 22.17	1.06/1.18	19/19	26/27	
2.Gender	0.49/ 0.53	0.50/0.50	0 (female)	1 (male)	Male:98/106; Female:102/94
3. C2C purchase experience	4.92/ 5.04	0.80/0.85	3/4	7/7	7 point scale (rarely–very frequently)

Note: The values shown on the left side of “/” are from the group without contrast, and those shown on the right side of “/” are from the group with contrast.

Table 4
Results for measurement model.

Construct	Items	Mean	S.D.	AVE	C.R	C.A.	Loading	VIF
Visual complexity	COM1	4.21/4.23	1.75/2.00	0.69/0.80	0.90/0.94	0.85/0.91	0.81/0.84	2.10/2.99
	COM2	3.99/4.20	1.70/1.97				0.76/0.88	2.08/2.73
	COM3	4.15/4.14	1.61/1.98				0.95/0.91	1.96/2.84
	COM4	3.85/3.85	1.74/1.95				0.78/0.93	1.94/3.60
Complexity contrast	CON1	−/5.68	−/1.22	−/0.70	−/0.87	−/0.78	−/0.83	−/1.88
	CON2	−/5.75	−/1.38				−/0.79	−/1.53
	CON3	−/5.21	−/1.45				−/0.87	−/1.62
Perceptual fluency ^a	PERF1	4.91/5.23	1.47/1.05	−/−	−/−	−/−	0.83/0.88	2.65/3.07
	PERF2	4.44/5.05	1.45/1.13				0.82/0.75	2.51/3.21
	PERF3	4.68/5.24	1.39/1.11				0.81/0.87	2.69/2.88
	PERF4	4.57/4.99	1.43/1.08				0.94/0.66	3.03/3.20
Conceptual fluency	CONF1	4.39/4.65	1.34/1.14	0.82/0.73	0.89/0.84	0.78/0.63	0.93/0.81	1.72/1.27
	CONF2	4.24/4.26	1.33/1.20				0.88/0.89	1.71/1.27
Pleasantness	PLEA1	4.22/4.47	1.28/1.49	0.76/0.81	0.91/0.92	0.84/0.87	0.91/0.92	1.90/2.45
	PLEA2	4.16/4.43	1.30/1.53				0.90/0.89	2.13/2.49
	PLEA3	4.15/4.28	1.36/1.50				0.81/0.88	2.17/2.57

Note: S.D.: standard deviation. C.R.: composite reliability. C.A.: Cronbach's alpha. The values on the left side of "/" are from group without contrast, and those on the right side of "/" are from group with contrast. "−" means the value is unavailable.

^a formative measures need not co-vary, therefore the internal consistency of formative items of Perceived Risk is not applicable

Table 5
Correlations among constructs.

Construct	1	2	3	4	5
1 Visual complexity	0.83/0.89 ^a	−0.58	−0.54 ^b	−0.61	−0.68
2 Complexity contrast	−	−/0.83	0.69	0.52	0.61
3 Perceptual fluency	−0.65	−	0.86/0.79	0.29	0.59
4 Conceptual fluency	−0.50	−	0.34	0.90/0.85	0.58
5 Pleasantness	−0.64	−	0.59	0.46	0.87/0.90

^a The values on the diagonal represent the square root of the AVEs; the values on the left side of "/" are from group without contrast, and those on the right side of "/" are from group with contrast;

^b Correlations for the group with contrast are shown in the upper triangle, and correlations for the group without contrast are shown in the lower triangle.

loadings of the measures on their corresponding construct; (2) internal consistency, which is reflected by composite reliability and Cronbach's alpha coefficient of each construct; and (3) discriminate validity, which is mainly represented by average variances extracted (AVE) from each construct (Yoo and Alavi, 2001). Furthermore, the issue of multi-collinearity is checked. The result of the measurement model test is shown in Tables 4 and 5.

For individual item reliability, the factor loading of about 0.7 or greater is desired, whereas a value below 0.5 shows low trait variance (Bagozzi, 2011). Thus, the cut-off point is set at 0.5. Table 4 shows that all factor loadings exceed 0.5.

Composite reliability and Cronbach's alpha are both used for evaluating the internal consistency of the constructs, and 0.7 is the recommended threshold for both indices (Bagozzi, 2011). It can be seen from Table 5 that all constructs have met this criterion.

AVE is the average variance shared between a construct and its measures. All AVEs shown in Table 4 are greater than the recommended value (0.5), suggesting that the latent constructs account for the majority of the variance in their indicators on average (MacKenzie et al., 2011). Table 5 shows that the square roots of AVEs are all larger than corresponding correlations (Rezaei, 2015). Thus, discriminate validity is observed.

As shown in Table 5, several inter-construct correlations, for example, the correlation between visual complexity and perceptual fluency, between visual complexity and pleasantness, and between complexity contrast and perceptual fluency, are over the value of 0.60. This suggests that multi-collinearity might be a potential problem for this study (Grewal et al., 2004). By following Ke and Zhang (2010), the Variance Inflation Factors (VIFs) and Tolerance values of the constructs are used to assess multi-collinearity. As a common rule, the presence of a multi-collinearity issue is confirmed if VIFs are higher than 10 (Mason and Perreault, 1991). More strictly, a VIF threshold of 3.3 has been recommended by Cenfetelli and Bassellier (2009). In our study, the results shown in Table 4 suggest that only one VIF value is above 3.3 (COM4: 3.60), which indicates that multi-collinearity is not a serious issue.

5.4.2. Structural model

First, age, gender, and purchase experience are included as control variables in the model with a full sample size. Results show that *p*-values for these three variables are 0.23, 0.30 and 0.20 for the group without contrast, and 0.46, 0.49 and 0.39 for the group with contrast, respectively. Therefore, no significant effects of control variables are found.

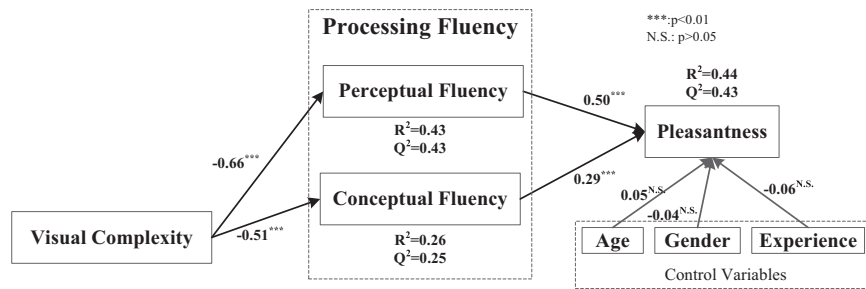


Fig. 2. Results of the structural model (group without complexity contrast).

In the structural model test, we follow suggestions from previous studies (Ben Mimoun and Poncin, 2015; Kushwaha and Agrawal, 2015) and use R -square (R^2), Q -square (Q^2), effect size, and Goodness-of-Fit (GoF) to assess the overall model fit.

The percentage of the variance explained (R^2) of perceptual complexity, conceptual complexity, and pleasure, respectively, are 43%, 26%, and 44% in the group without complexity contrast and 51%, 42%, and 54% in the group with complexity contrast. The relatively high values of R^2 reflect the model's good predictive accuracy. Q^2 coefficient (Geisser, 1975) is a resampling analog of the R^2 coefficient used to show a model's predictive relevance. In SEM models, a Q^2 value greater than zero implies the model's predictive relevance for its related construct (Rezaei, 2015). As it is shown in Figs. 2 and 3, all Q^2 values are above zero. The effect size shows the impact of a given predictive construct on an endogenous latent construct. Its values, 0.02, 0.15, and 0.35, are described as small, medium, and large effect sizes. In our two models, the values range from 0.12 to 0.43, which are beyond the acceptable level. The two GoF values in our two models are 0.56 and 0.64, which are higher than GoF good-fit cutoff point (0.36), suggesting that our models have good overall fitness.

Figs. 2 and 3 show the results of the structural model group without and with high complexity contrast, respectively. The results suggest that pleasantness is positively influenced by both perceptual fluency (without high contrast: $\beta=0.50$, $S.E.=0.064$; with high contrast: $\beta=0.47$, $S.E.=0.065$) and conceptual fluency (without high contrast: $\beta=0.29$, $S.E.=0.067$; with high contrast: $\beta=0.44$, $S.E.=0.065$). Thus, both H1 and H2 are supported. The results also suggest that complexity negatively influences perceptual fluency (without high contrast: $\beta=-0.66$, $S.E.=0.062$; with high contrast: $\beta=-0.21$, $S.E.=0.068$) and conceptual fluency (without high contrast: $\beta=-0.51$, $S.E.=0.064$; with high contrast: $\beta=-0.47$, $S.E.=0.065$). Thus, both H3 and H4 are supported. For the impacts of complexity contrast, the results suggest that complexity contrast positively influences both perceptual fluency ($\beta=0.57$, $S.E.=0.063$) and conceptual fluency ($\beta=0.24$, $S.E.=0.067$). Both H5 and H6 are therefore supported.

To test H7 and H8 we conducted two unpaired t -tests. The beta coefficients from complexity contrast to perceptual fluency (conceptual fluency), and from visual complexity to perceptual fluency

(conceptual fluency) were compared. The t -test results suggest that complexity contrast has a greater influence than visual complexity on perceptual fluency ($t=54.92$, $p < 0.001$), but visual complexity has a greater influence than complexity contrast on conceptual fluency ($t=34.84$, $p < 0.001$). Therefore, H7 and H8 are supported. H9 is also tested by two unpaired t -tests. The beta coefficients from visual complexity to perceptual fluency in two groups are compared. The results suggest that the influence of visual complexity on perceptual fluency was diminished statistically in the group with complexity contrast ($t=69.15$, $p < 0.001$). A similar result is also found regarding the influence of visual complexity on conceptual fluency ($t=6.20$, $p < 0.001$). Therefore, H9 is supported.

6. Discussion

6.1. Discussion of findings

The results firstly show that both types of processing fluency (perceptual and conceptual) influence pleasantness positively, indicating that if buyers perceive the information pieces shown in a product picture as easy to identify and understand, their feeling towards the shopping task may be more favorable. Our finding is consistent with previous studies.

Secondly, visual complexity of the product image is found to negatively influence processing fluency. If a seller chooses to include more product or service highlights in a product picture, the visual complexity of the product picture increases. As a result, it will require more effort on behalf of the buyers to identify each piece of information (e.g., the space between some words in the picture will be narrow, or the words may be even overlapping), and to understand the meaning of information pieces (e.g., the material used to build the fishing rod is highlighted but will require more effort to decide if this material is suitable or not).

Thirdly, complexity contrast shows a strong impact on perceptual fluency but a weak impact on conceptual fluency. Contrast itself does not directly lead to a high level of processing; rather it is more associated with the speed of locating information cues. This result is in line with studies on visual search, which suggest that

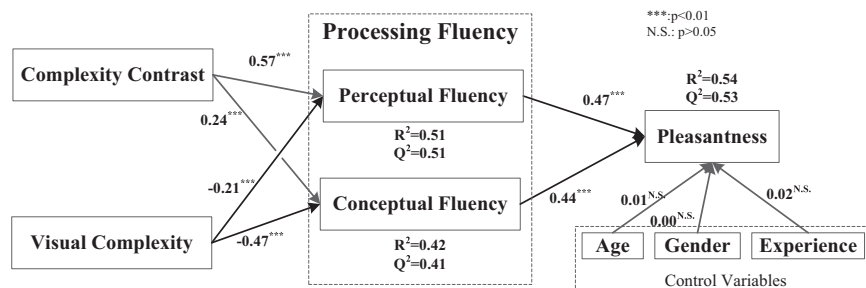


Fig. 3. Results of the structural model (group with complexity contrast).

the level of dissimilarity between targets and distractors affects search efficiency (Roper et al., 2013). However, since contrast induces selective attention, which further leads cognitive resources to be allocated more on the target picture but less on other distractors, the speed of conceptual processing might be improved.

The most interesting finding is the entangled effects of visual complexity and complexity contrast. The results in this study show that when complexity contrast is introduced, the impacts of visual complexity on both types of processing fluency decrease. Therefore, the influence of complexity contrast over processing fluency appears to be substitutive, rather than additive, to that of visual complexity. Moreover, complexity contrast not only has a stronger effect on perceptual fluency than visual complexity, but also has a significant effect on conceptual fluency. It seems that in online marketplaces, buyers are influenced more by the conspicuousness of a product picture rather than the meaning conveyed by the product picture. Although pictures enjoy a superiority effect and they can convey information better than textual messages (Geise and Baden, 2015), if a buyer is overwhelmed by complex pictures, he may not choose to read product highlights from complex pictures; instead, he may click a conspicuous picture, go to product detail page and read text-based product highlights.

6.2. Implications

This study yields two theoretical implications. First, the result enriches current literature on visual complexity. Previous studies focus more on consumers' perception of the complexity of a whole webpage or a banner ad; however, how best to consider visual complexity in designing other web elements (e.g., search lists or product pictures) is unknown. In traditional online stores, some web elements, such as banner ads and navigation bars, may not earn much attention as they are not the most important parts of the web page. But in online marketplaces, web elements (e.g., different product pictures) compete against each other for visual attention. Second, almost no prior attention has been paid to complexity contrast, while other forms of visual contrast (e.g., color contrast and font size contrast) have received much more attention. By introducing complexity contrast, this study considers the impacts of environmental factors on consumers' processing of a visual object; previous studies, however, are largely concerned with consumers' responses to the visual object only (Martin et al., 2005; Michailidou et al., 2008). Moreover, our finding enriches the knowledge on processing fluency. Previous studies usually link visual salience to the perceptual level of processing. Our results support the fact that visual salience can have an impact at both the perceptual level and the conceptual level.

This study also generates two practical implications. First, the results show the importance of processing fluency, especially perceptual fluency, on the shopping experience of buyers. Therefore, sellers should find ways to reduce buyers' effort to process product information, including the ease of locating and understanding product information. Placing product information at sponsored positions in the product list could draw buyers' attention quickly, but it also significantly increases the sales cost. On the contrary, making product images conspicuous provides a more viable way to earn buyers' attention. Second, in online marketplaces, sellers are suggested to adjust their advertising strategies to adapt to the dynamically changing environment. In the initial stage of advertising, highlighting product or service advantages is important for business. However, as the advertising strategy evolves to become homogeneous (e.g., every seller uses complex product pictures), attracting people's attention becomes more important than letting people know what the object is trying to convey.

6.3. Limitations

This study has a number of limitations, which together point out the directions of future work. First, the manipulation of visual complexity in the experiment mainly relies on the amount of product or service information, whereas product or service information may be written in different colors and fonts to produce complexity. Since we use human subjective perceptions to measure visual complexity, we assume that the issue of color and font does not have a significant influence on experiment results. Future work will consider the effects of different types of complexity. Second, the sample (undergraduate students) reflects a typical group of buyers in online marketplace; however, they cannot be representative of the whole consumer community. Moreover, in the lab experiment, participants were required to have purchase experience with online marketplaces but little knowledge about target product; therefore, the findings may not be stable in other circumstances (e.g., a buyer has prior knowledge). Future studies may take more buyers' characteristics (e.g., age and/or knowledge level) into consideration. Third, this study only considers a Chinese online marketplace as its research context. Previous studies on advertising suggest that consumers from countries with logographic writing systems (e.g., China, Japan, Korea) are more attuned to visual components than those from countries with phonological language systems (e.g., United States) (Henderson et al., 2003). Therefore, it is necessary to extend this study to different countries. However, it is reasonable to argue that the research model and implications will still be valuable because the theory of selective attention applies to all people regardless of country differences.

7. Conclusion

In online marketplaces, buyers are usually overwhelmed by a large number of product choices. Therefore, determining how to advertise product information is important for each seller as it is linked to the probability of being chosen as an alternative. In order to maximize the use of limited advertising space, many sellers write product or service highlights into product pictures. In this way, buyers can be satisfied through the reduction of processing effort and an increase of positive affect, for example by making it unnecessary in many cases to read through product detail pages. This advertising strategy can bring a competitive advantage in the beginning; however, when other sellers also use complex product images to advertise, this strategy turns out to be inefficient, as a serious overload problem causes buyers difficulty in locating and processing a given product image. To deal with this problem, many sellers begin to adopt differentiated advertising strategies by posting simple product pictures among complex ones or posting complex pictures among simple ones. However, the advertising effectiveness remains unclear.

This study proposes a theoretical model based on the S-O-R framework to explain the impact of visual complexity and complexity contrast on buyers' processing fluency in the stage of alternative evaluation. Four hundred participants were invited to participate in a lab experiment, and PLS analysis of survey data shows that the influence of complexity contrast over processing fluency appears to be substitutive to that of visual complexity, indicating that buyers prefer conspicuousness to information richness in product pictures. This result supports the effectiveness of the advertising strategies that emphasize using differentiated product ads.

Appendix A

See Appendix Fig. A1 here



Fig. A 1. A list of product pictures with complexity contrast (Condition 3).

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